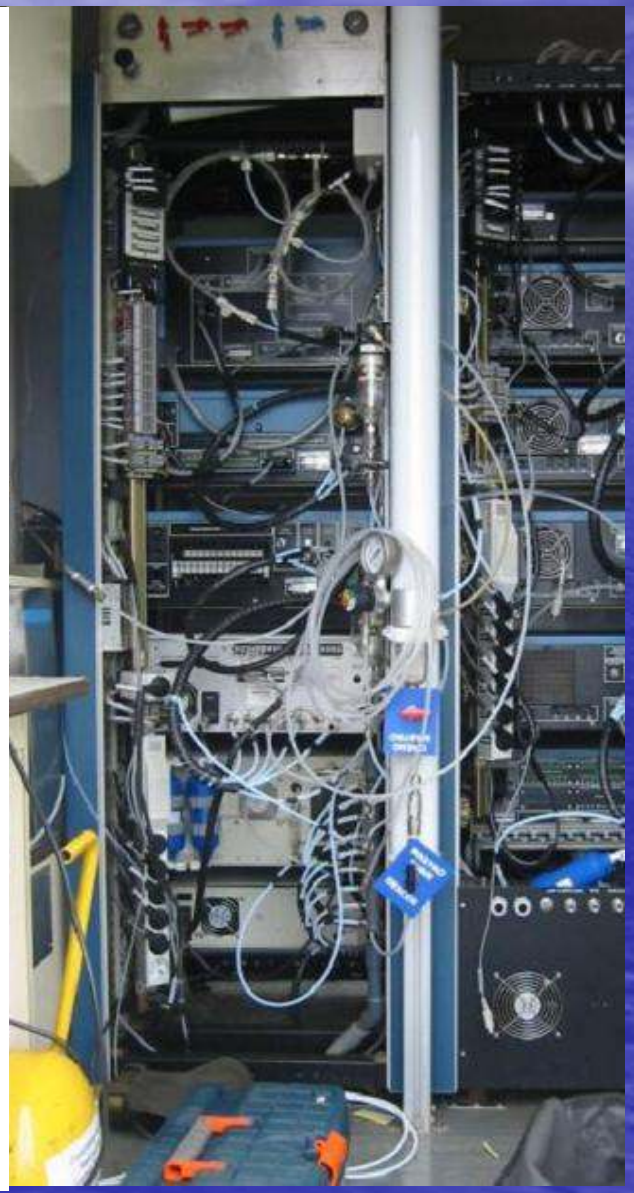
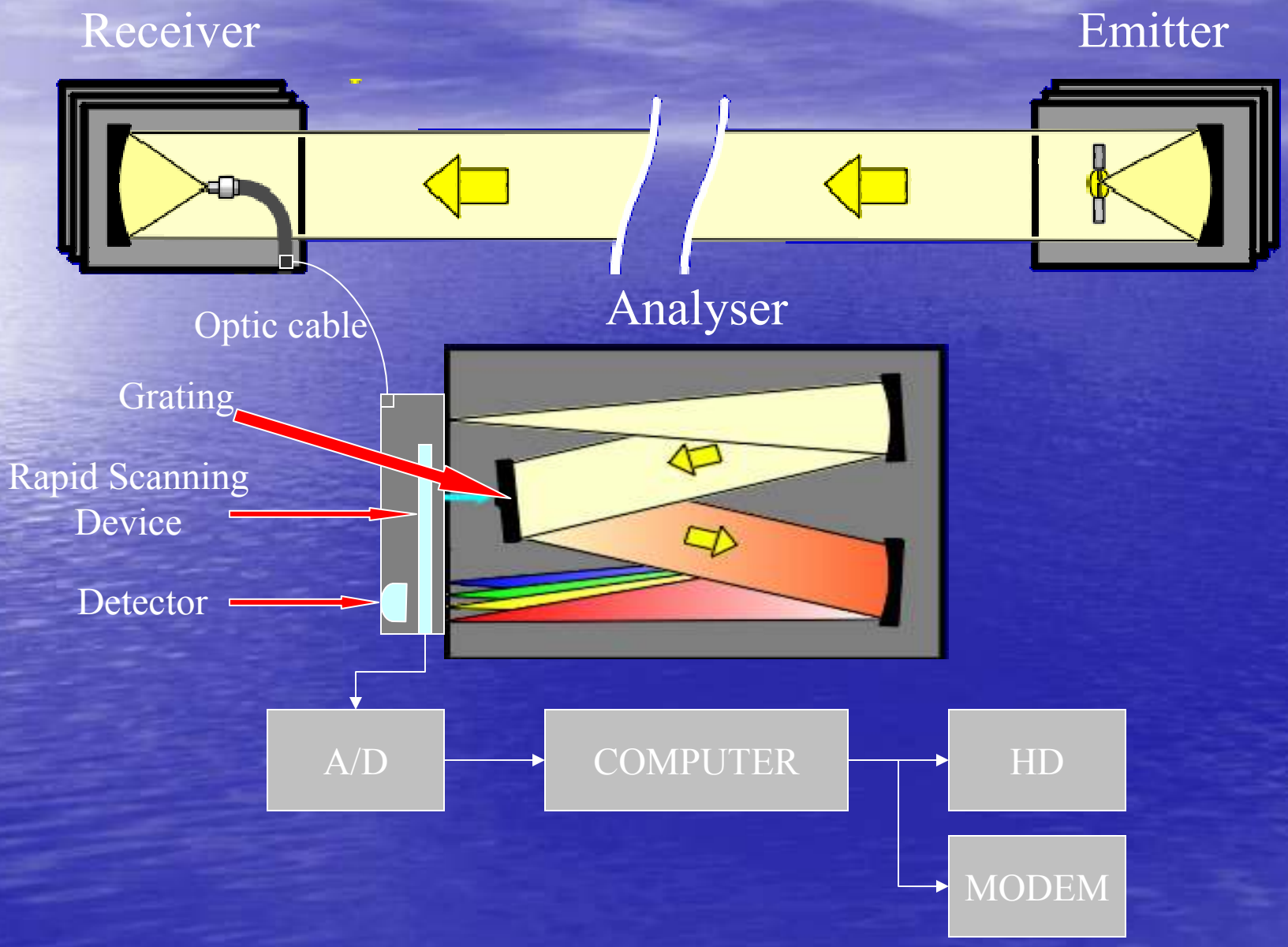
Current advances in Open Path DOAS measurements for Criteria and Toxic parameters

2006 Air Monitoring Conference
Las Vegas, Nevada
November 2006
Paul Stenberg

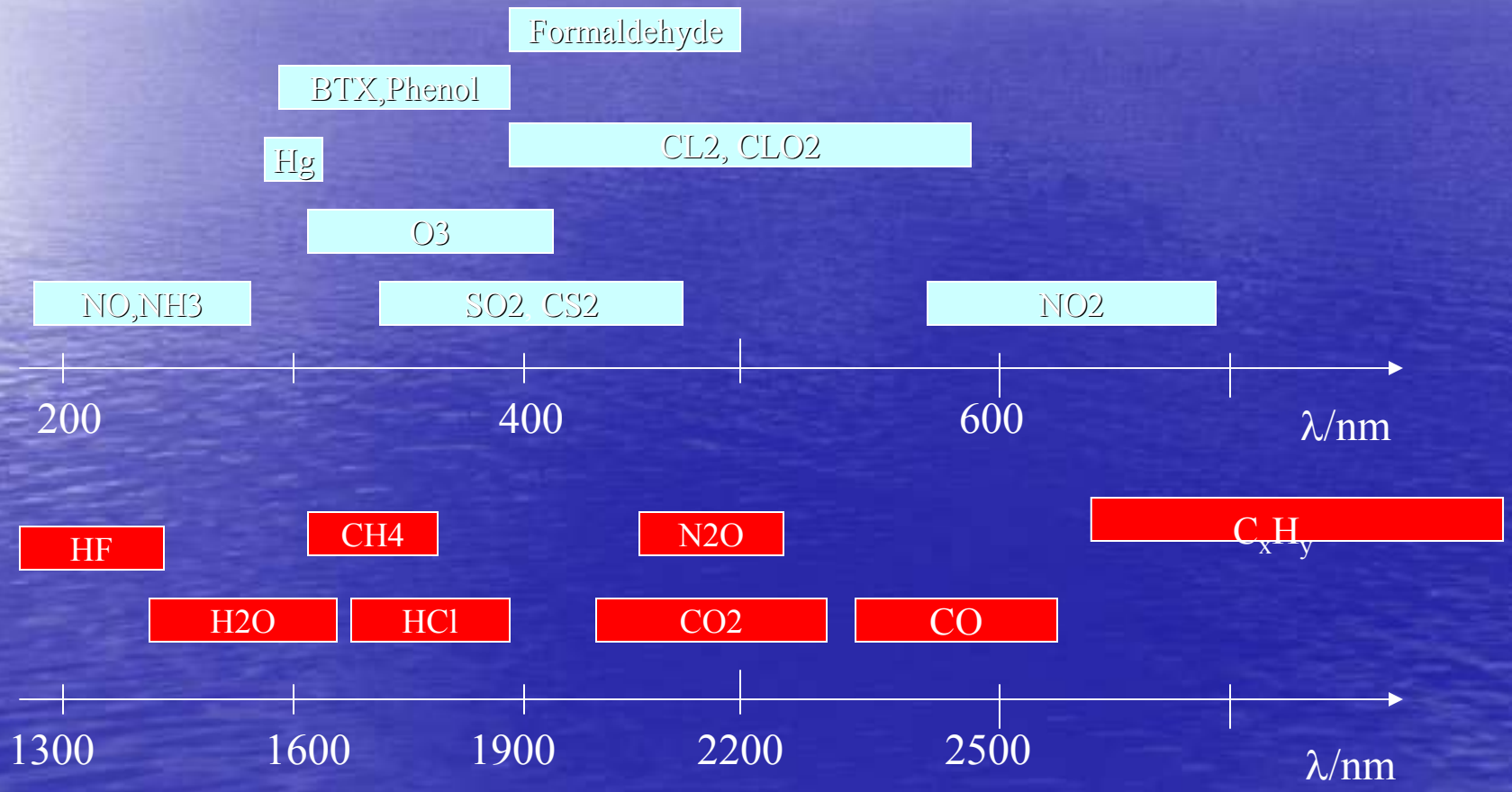
THE ALTERNATIVES !



SYSTEM DESIGN

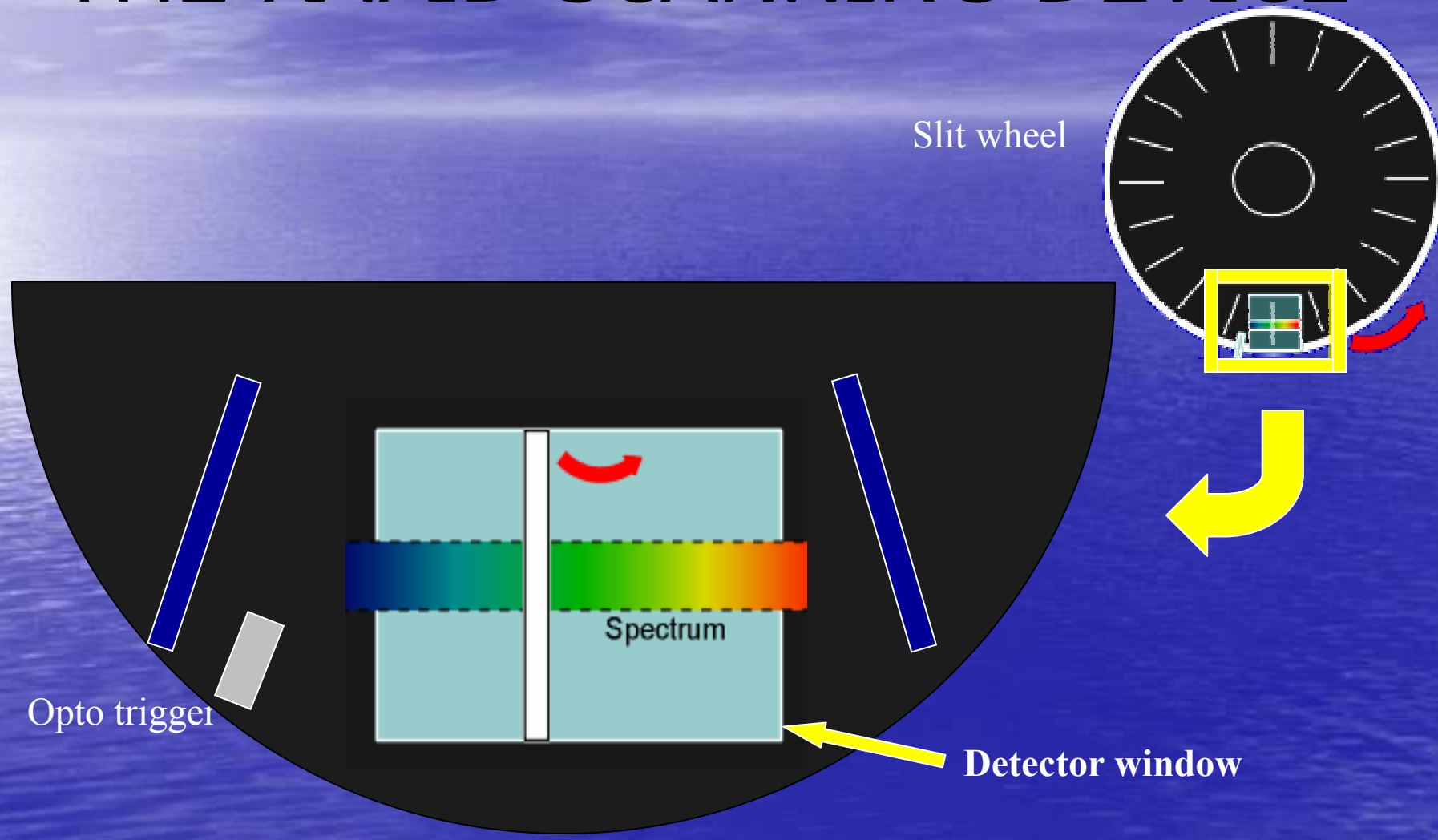


WAVELENGTH REGIONS

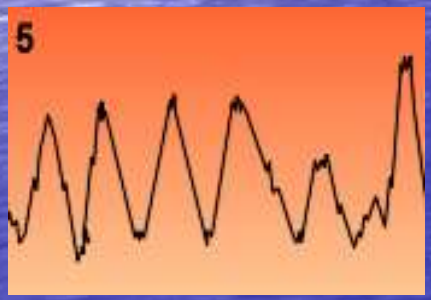


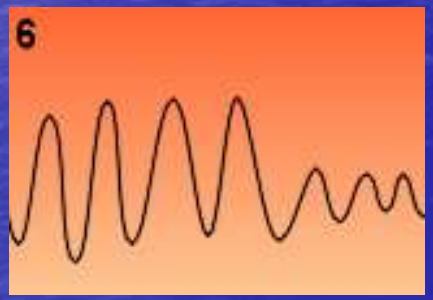
Example of light attenuation

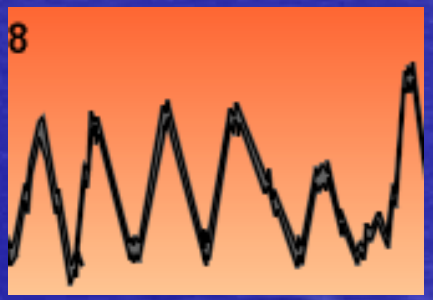
THE RAPID SCANNING DEVICE



SPECTRAL EVALUATION



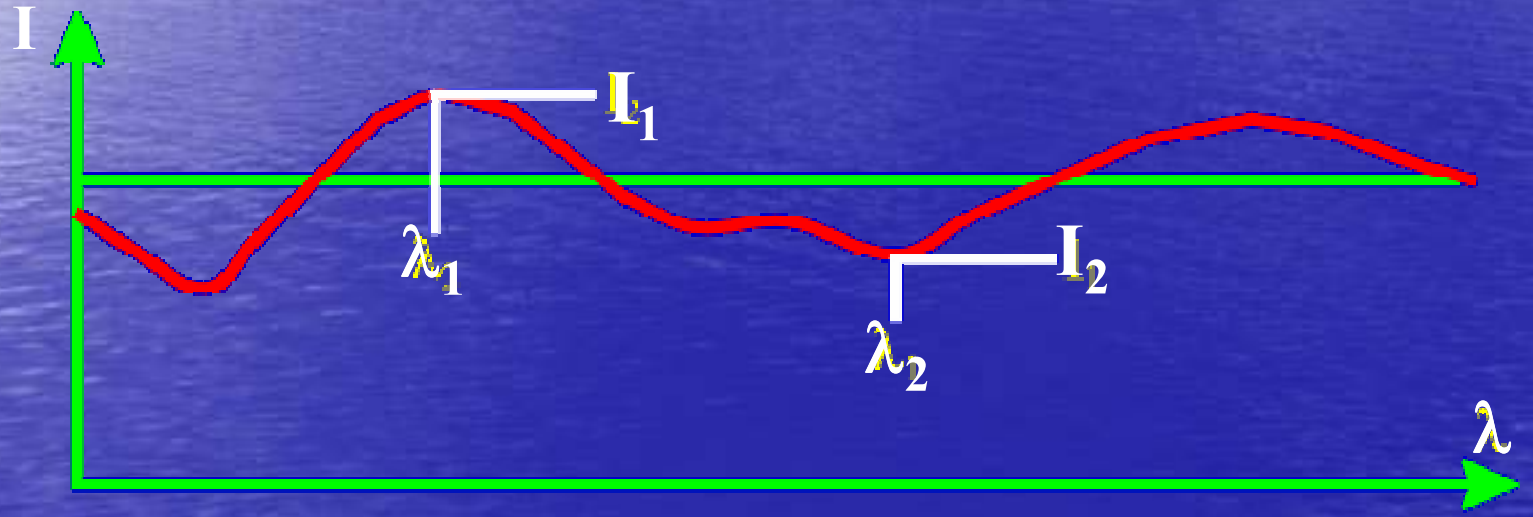




The Beer Lambert Law

$$I_1 = I_0^{-c\alpha_1 l}$$

$$\ln (I_2/I_1) = c(\alpha_1 - \alpha_2)l$$



GRATINGS

- MOVEABLE
- RESOLUTION
- COATINGS
- MULTIPLE

EU Directives for Benzene

Recommended Concentration Levels:

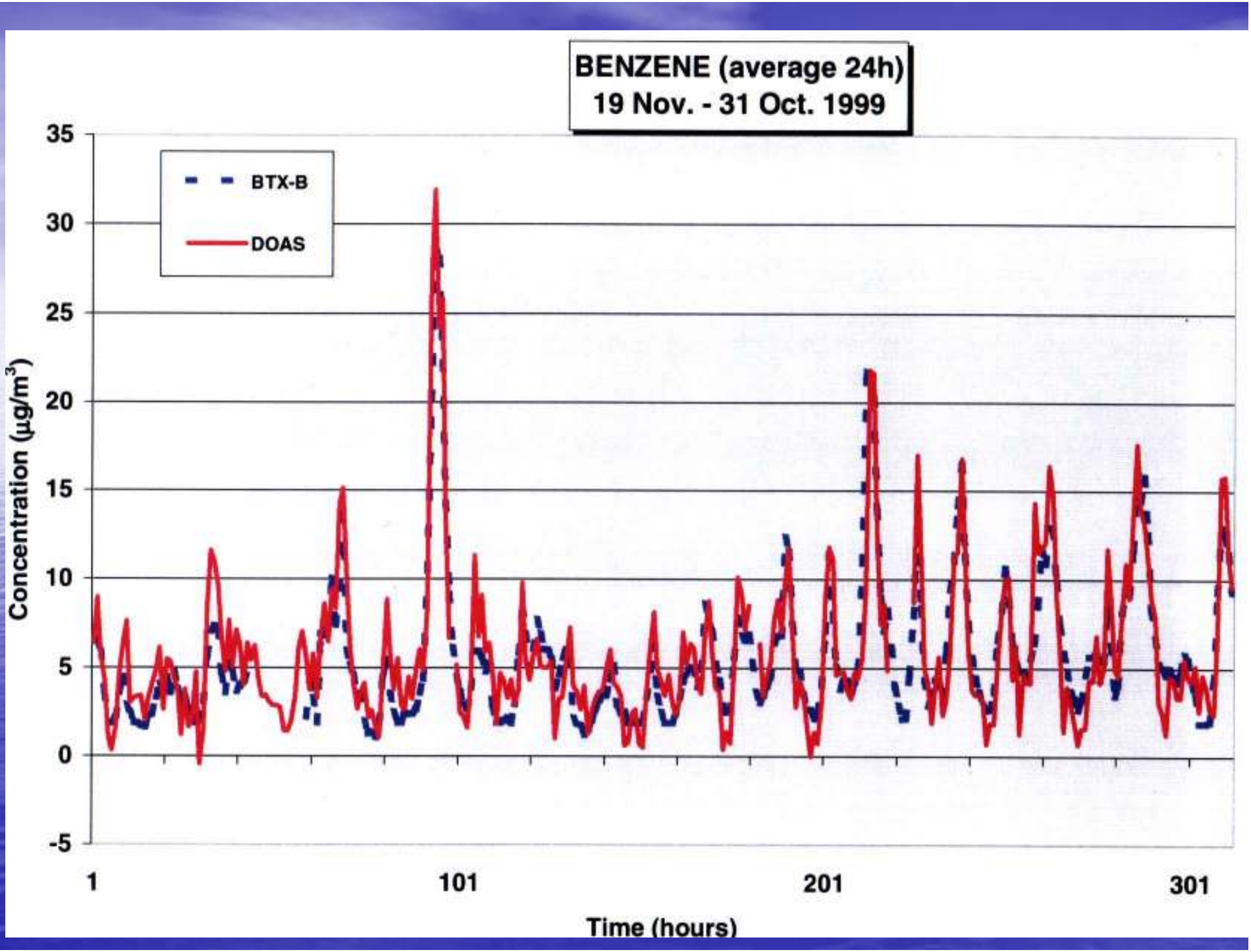
Today: 10 µg/m^3 as annual mean value

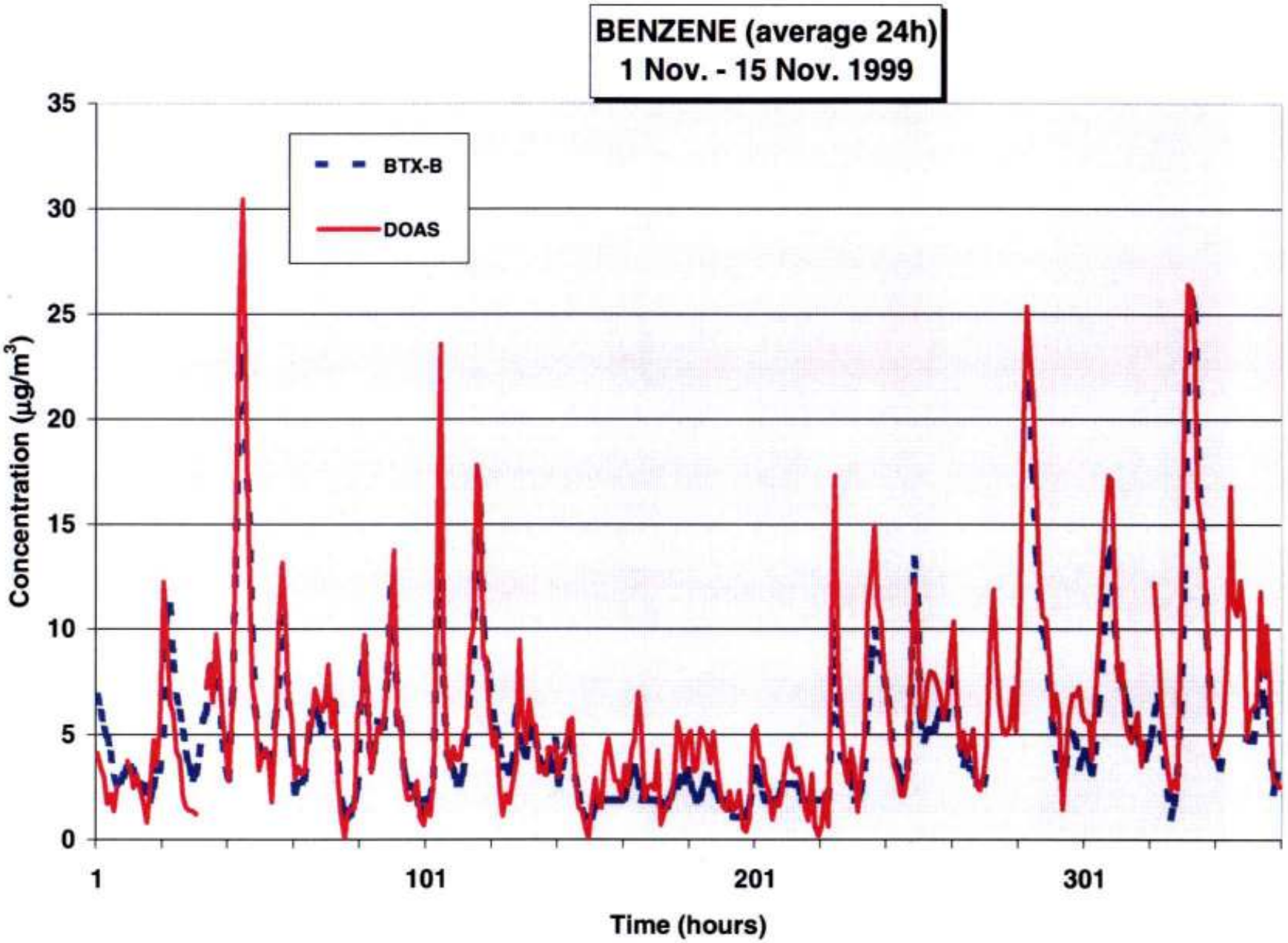
In 2010: 5 µg/m^3 as annual mean value

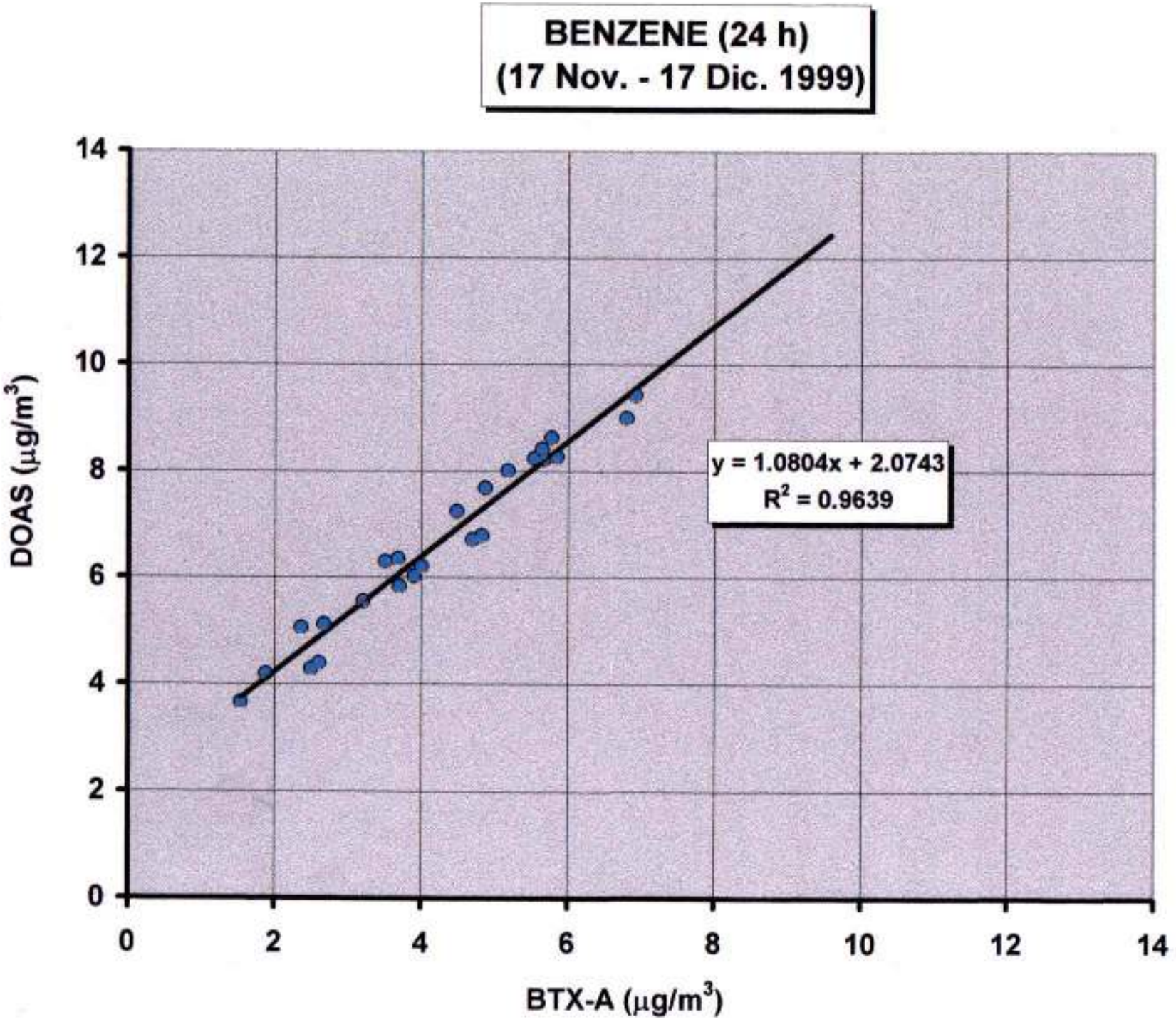
Reference Method: Gas chromatograph
Equivalent Method: DOAS (only Opsis approved by German TUV)

Benzene Test Site at TÜV Rheinland, Germany

Two co-located Opsis DOAS systems and one on-line GC

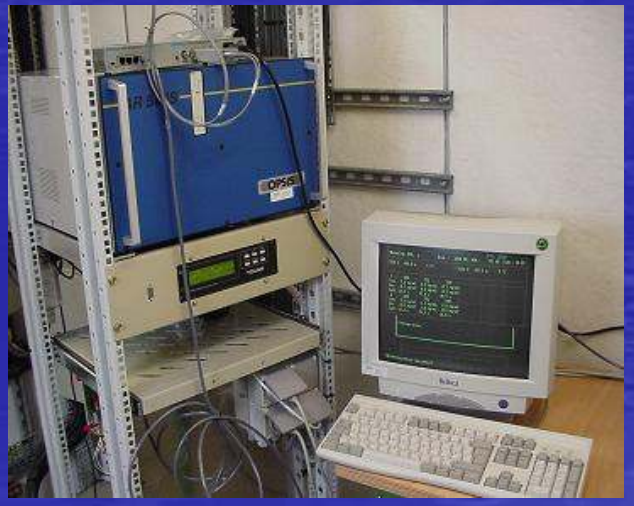

BENZENE (average 24h)
19 Nov. - 31 Oct. 1999
BTX-B
DOAS
Concentration (µg/m³)
35
30
25
20
15
10
5
0
-5
1
101
201
301
Time (hours)


BENZENE (average 24h)
1 Nov. - 15 Nov. 1999
BTX-B
DOAS
Concentration (µg/m³)
35
30
25
20
15
10
5
0
1
101
201
301
Time (hours)

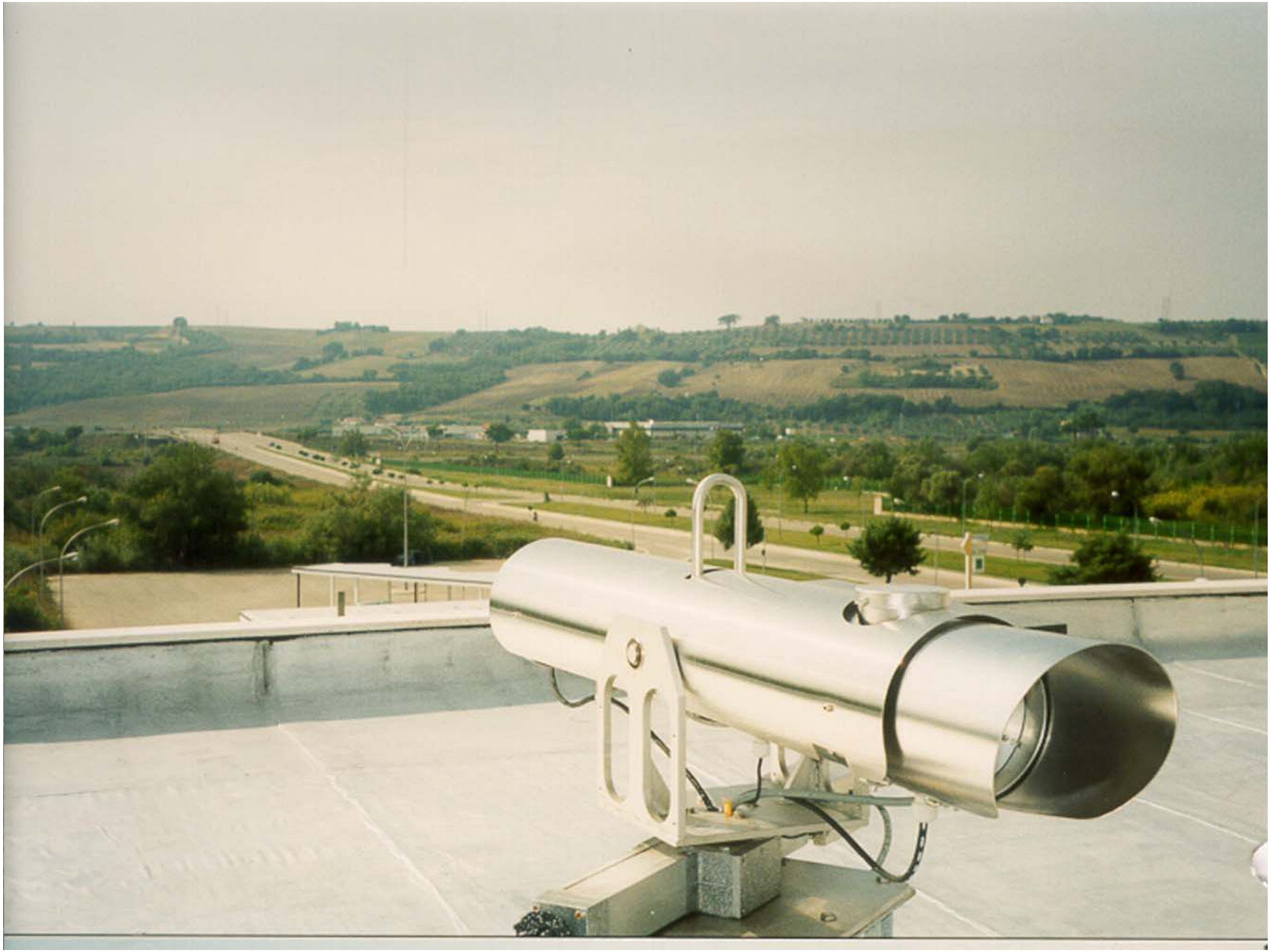

BENZENE (24 h)
(17 Nov. - 17 Dic. 1999)
y = 1.0804x + 2.0743
R² = 0.9639
DOAS (µg/m³)
BTX-A (µg/m³)
0
2
4
6
8
10
12
14

WARNING !
HOT PARTS
OPSIS

BP, BELGIUM



OPSIS
OPSIS



CALIBRATION

Optical density

$$C_p \times L_p = C_c \times L_c$$

C_p= Concentration in the path

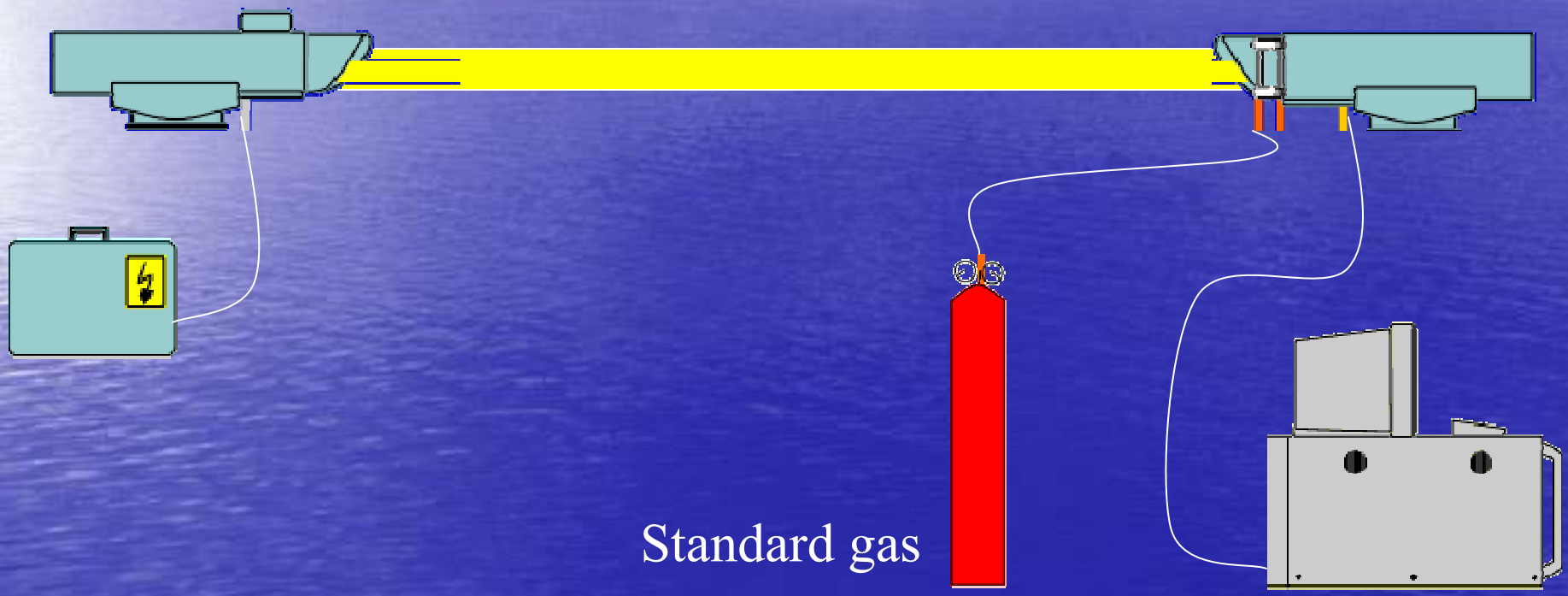
L_p= Length of the path

C_c= Concentration in the cell

L_c= Length of the cell

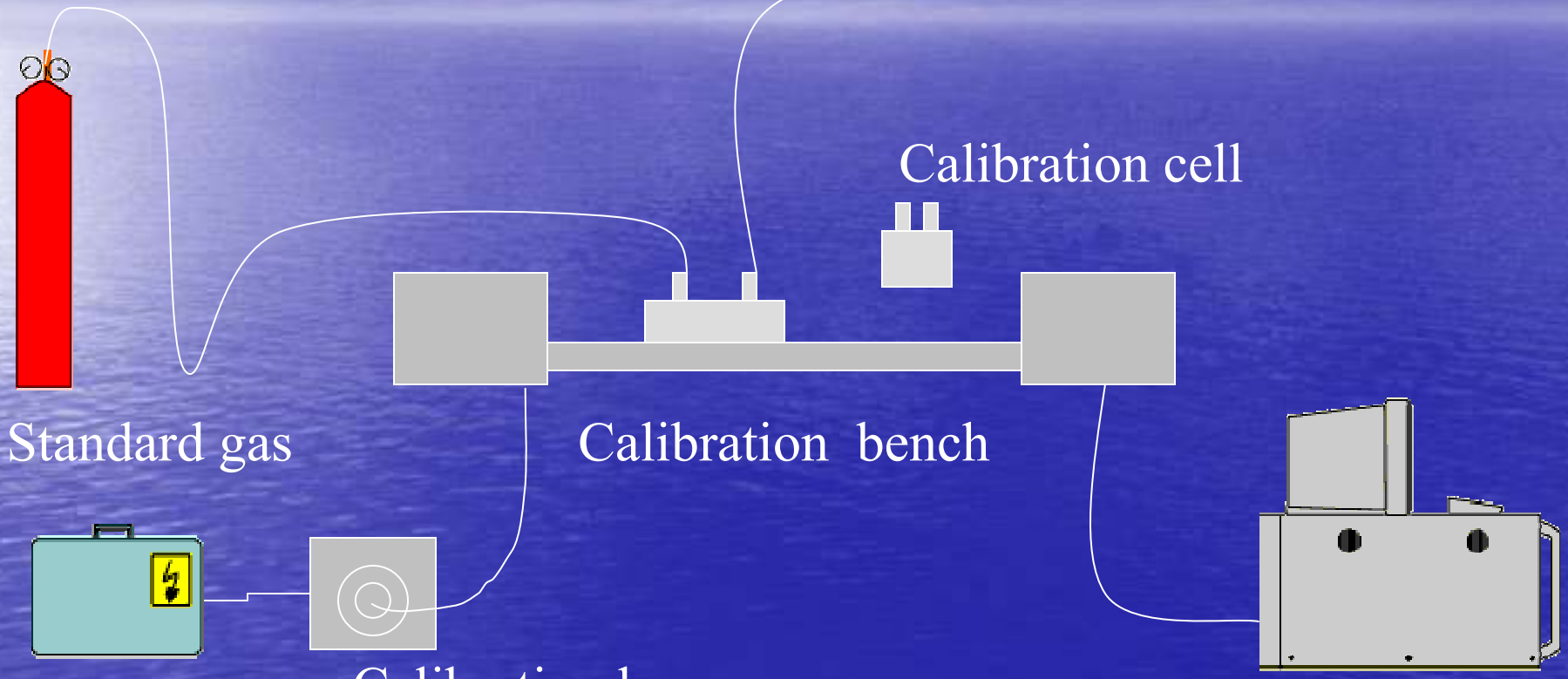
CALIBRATION

Performance Audit



CALIBRATION

Manual span and zero bench calibration



SUMMARY

- DOAS SIMPLIFIES MULTIPARAMETER MEASUREMENTS
- DOAS TECHNOLOGY HAS EVOLVED OVER THE LAST 15 YEARS
- DOAS OPEN PATH HAS BEEN PROVEN TO CORRELATE WITH TRADITIONAL POINT MEASUREMENTS
- DOAS IS VERY VERSITILE
- OPSIS DOAS CONFORMS TO USEPA CALIBRATION REQUIREMENTS